Change No. 1

DEPARTMENTS OF THE ARMY
AND THE NAVY
WASHINGTON, D.C., *19 December 1969*

STAFF OFFICERS' FIELD MANUAL
NUCLEAR WEAPONS EMPLOYMENT
DOCTRINE AND PROCEDURES

FM 101-31-1/FMFM 11-4, 15 February 1968, is changed as follows:

1. Remove old pages and insert new pages as indicated below.

Remove pages	*Insert pages*
1-1 and 1-2	1-1 and 1-2
2-1 and 2-2	2-1 and 2-2
2-15 and 2-16	2-15 through 2-16
3-1 through 3-6	3-1 through 3-6
3-9 through 3-12	3-9 through 3-12
4-7 through 4-14	4-7 through 4-13
5-1 through 5-4	5-1 through 5-4
6-3 and 6-4	6-3 and 6-4
B-1 through B-4	B-1 through B-4
B-11 and B-12	B-11 and B-12
B-23 and B-24	B-23 and B-24
B-31 and B-32	B-31 and B-32
B-43 and B-44	B-43 and B-44
B-55 and B-56	B-55 and B-56
B-59 and B-60	B-59 and B-60
B-65 and B-66	B-65 and B-66
Glossary-1	Glossary-1, Glossary-2

2. A star indicates new or changed material.
3. File this change sheet in front of the manual for reference purposes.

FIELD MANUAL No. 101-31-1
FLEET MARINE FORCE MANUAL No. 11-4

DEPARTMENTS OF THE ARMY AND THE NAVY
WASHINGTON, D.C., *15 February 1968*

STAFF OFFICERS' FIELD MANUAL
NUCLEAR WEAPONS EMPLOYMENT
DOCTRINE AND PROCEDURES

*This manual supersedes FM 101-31-1, 1 February 1963, including all changes.

Table 2–1 Biological Response to Nuclear Radiation

Estimated exposure range (rads)	*Initial symptoms*	*Onset of symptoms*	*Incapacitation*	*Hospitalization*	*Duration of hospitalization*	*Final disposition*
50 to 200	None to transient mild headache.	Approximately 6 hours after exposure.	None to slight decrease ability to conduct normal duties.	Hospitalization reququired for less than 5 percent in upper part of exposure range.	45 to 60 days in upper part of range.	Duty. No deaths anticipated.
200 to 500	Headaches, nausea, and vomiting; malaise. Symptoms not relieved by antimetics in upper part of exposure range.	Approximately 4 to 6 hours after exposure.	Can perform routine tasks. Sustained combat or comparable activities hampered for period of 6 to 20 hours.	Hospitalization required for 90 percent of exposed personnel in this range. Hospitalization follows latent period of 17 to 21 days' duration.	60 to 90 days	Some deaths anticipated; probably less than 5 percent at lower part of range, increasing toward upper end.
500 to 1,000	Severe and prolonged nausea and vomiting; difficult to cure. Diarrhia and fever early in upper part of exposure range.	Approximately 1 to 4 hours after exposure.	Can perform only simple, routine tasks. Significant incapacitation in upper part of exposure range; lasts more than 24 hours.	Hospitalization required for 100 percent of exposed personnel. Latent period short, 7 to 10 days in lower range to none in upper range.	90 to 120 days for those surviving.	Approximately 50-percent deaths at lower part of range, increasing toward upper end; all deaths occurring within 45 days.
Greater than 1,000	Severe vomiting, diarrhea, and prostration.	Less than 1 hour after expousre.	Progressive incapacitation, following an early capability for intermittent heroic response.	Hospitalization required for 100 percent of exposed personnel. No latent period.	3 to 30 days	100 percent deaths occurring within 30 days.

4–3. Acquisition of Surface Targets

a. Target acquisition is that part of intelligence activities which involves detection, identification, and location of ground targets. The information obtained is used for target analysis, target evaluation, and employment of weapons. Information is collected from all sources and agencies.

b. The effectiveness of a nuclear attack depends, to a great extent, on the accuracy, completeness, and timeliness of intelligence. Specific information of target areas, to include location, size, shape, composition, concentration, vulnerability, recuperability, and permanence or direction and speed of movement, is continually sought by all intelligence collection agencies. The degree to which this information is complete and accurate influences the accuracy of the damage estimation and the validity of the target analysis. The degree to which the information is timely influences the effectiveness of the attack.

c. The limited visual field of an observer frequently restricts his ability to observe in its entirety an area target appropriate for attack with nuclear weapons. A single observer seldom has the capability to provide sufficient target information on which to base a target analysis and a decision to fire. This limitation demands that a detailed collection plan be developed and that target information be collected from all available sources. A target suitable for attack with nuclear weapons frequently may be acquired at a higher echelon of command by the analysis and the integration of apparently unrelated items of information received from several sources.

d. Because of the foregoing aspects of target acquisition, the importance of the commander's initial staff planning guidance cannot be overemphasized. Such guidance provides the basis for developing the essential elements of information and the detailed collection plan. The commander isolates those enemy activities which, if they should materialize, would seriously affect the accomplishment of his mission. He then establishes the priorities of the intelligence collection effort. Failure to establish these priorities, or failure to concentrate the collection effort on those enemy activities which would pose a serious threat to accomplishment of the mission, risks overextending the capabilities of the collection agencies. Such overextension results in inadequate target acquisition.

e. A detailed plan for the collection of target information is developed and revised continually throughout an operation (para II–4, app B).

(1) An analysis of the terrain, a study of the enemy order of battle, and an understanding of enemy tactics will produce a list of areas in which the enemy might locate reserves, logistical installations, command posts, nuclear delivery units, or other profitable targets.

(2) This list is studied to determine which areas, if occupied, adversely affect the accomplishment of the mission. The areas on this list are held to a minimum to avoid overextension of the collection agencies. Also, too large a list may degrade the capability of the (Army) tactical operations center (TOC) or (Marine) fire support coordination center (FSCC) to record and to interpret target information.

(3) When time permits, these prospective target areas are subjected to more intensive surveillance than is the remainder of the battle area. The items of information collected from this surveillance are used to determine the characteristics of the target.

f. A list of prospective target areas forms the basis for a list of suspected targets. A suspected target is one whose existence is known, but whose location is unknown; or it may be a location concerning which there is doubt whether it is occupied. Suspected targets are engaged with nuclear weapons when evaluation of the target indicates that a nuclear attack is justified. Target evaluation is discussed in paragraph 4–11*a*.

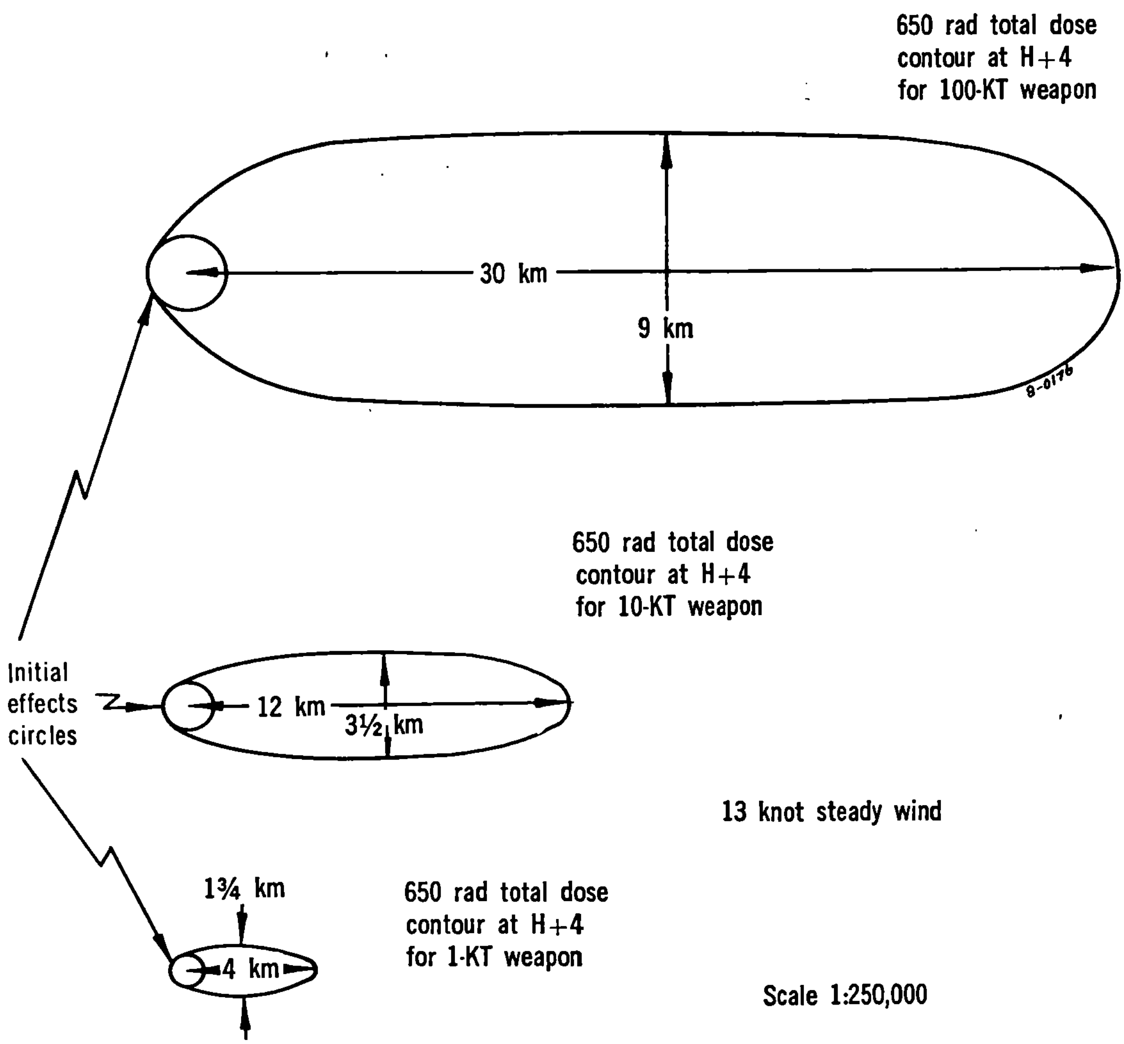

Figure 4-6. Comparison of initial effects and residual effects from 100-, 10-, and 1-kiloton surface bursts.

(*a*) The commander may decide that a suspected target is so important that he must attack it even though friendly intelligence agencies may not have been able to collect significant information on the target.

(*b*) Conversely, the commander may decide that a target is not of sufficient importance to warrant attack unless there is considerable certainty that the attack will be remunerative. In this respect, combat intelligence will seldom have the capability to provide complete target information. *Delay of nuclear attacks until detailed intelligence is developed may impede the effectiveness of the attack.* On the other hand, engagement of a target without some indication of its characteristics may cause an unwarranted waste of combat power.

b. Once targets have been evaluated and given a priority for attack, the *commander* determines whether to engage them with nuclear fires, nonnuclear fires, maneuver forces, or some combination of these means. The considerations that affect the attack of a target with a maneuver force and with nonnuclear fires are not discussed in this field manual.

c. There are many considerations that influence the decision to attack a target with nuclear weapons.

(1) The availability of weapons is considered in the estimate. This availability is governed by the authority to fire and by the physical location by both the delivery unit and the weapon(s) to be delivered.

(2) The time available to employ the weapon(s) influences the decision. Targets that are capable of moving may disappear subsequent to acquisition and prior to engagement if the timelag is significant.

(*a*) Time may be required to move the weapon(s), the delivery unit, or both, if they are not in a position from which the target can be engaged.

(*b*) Time is required for target evaluation, target analysis, fire direction, and preparation of the round for firing.

(*c*) Time is required to—

1. Warn subordinate units.

2. Coordinate with adjacent units into whose sector weapons effects may extend.

3. Notify friendly aircraft.

(3) The capability of the enemy to interfere with the friendly nuclear attack influences the decision. Means by which the enemy might interfere include attack of the friendly nuclear delivery means with either a maneuver force or firepower, electronic countermeasures, or interference with command and control facilities.

(4) The results of target analysis affect the estimate of the situation.

(*a*) The commander may consider that the results expected from a nuclear attack with a particular weapon are insufficient to warrant the expenditure of that nuclear weapon If the insufficient results are because the reliability of the weapon system is low, the commander may decide that the importance of the target is so great that a more reliable means must be used in its attack.

(*b*) Targets of a magnitude appropriate for attack with nuclear weapons are frequently ill-defined. Consequently, predictions of target coverage should not be given undue weight by the commander in making his decision.

(*c*) Analysis of the target may indicate that a nuclear attack will produce undesirable results. For example, the commander may decide that the target is not sufficiently important to warrant a risk to friendly troops greater than a negligible risk. Or, target analysis may indicate that obstacles may be created that will impede the accomplishment of the mission more than the expected results will assist.

(*d*) When target analysis indicates that the requirements established in the SOP cannot be met, the commander may decide to modify or revise the requirements so that the weapon(s) can be used. This revision of requirements may include one or more of the following:

1. Accepting less damage to the target.

2. Accepting a higher degree of risk for friendly troops.

3. Delaying the nuclear attack to permit friendly troops to acquire greater protection.

4. Accepting the possibility of obstacles or induced contamination in certain areas.

5. Accepting the possibility of damage to industrial complexes, structures, materiel, or objects that it is desirable to leave undamaged.

6. Accepting a higher probability of fallout.

d. As a result of the estimate of the situation, the commander decides the proper method of engaging each target. The authority to engage a target with a nuclear weapon normally is retained personally by the commander. In appropriate circumstances, the commander delegates this authority to a specifically designated representative.

4-12. Tactical Damage Evaluation

a. Tactical plans are based on the condition of the target area predicted in the target analysis. Once the nuclear attack has been made, the *primary* or an *alternate* plan is executed, depending on the results achieved. In some cases, the decision may be made to fire a backup weapon. The impact of damage, casualties, obstacles, or contaminated areas on the planned operation is considered prior to the commitment of exploiting forces. Situations may arise in which changes of direction or even cancellation of an attack is possible or necessary.

b. Following a friendly nuclear burst, every reasonable effort is made to determine the damage to enemy forces and their reaction to the attack and to obtain information concerning residual radioactivity, fires, and obstacles.

4-13. Distribution of Nuclear Ammunition

a. Commanders and staff officers continuously evaluate the capabilities and limitations of logistical systems to support nuclear weapon employment. Because of the decisive character and limited availability of nuclear ammunition, the distribution of this ammunition is an operational as well as a logistical problem. A special ammunition logistic element (SALE) is established at the army and corps tactical operations center to logistically assist the tactical commanders in expediting the supply of special ammunition (see FM 54-8 (Test)).

b. The nuclear ammunition logistical system is tailored to operate in different tactical situations, forms of warfare, and operational environments. Commanders and staff officers concerned with planning and controlling special ammunition support activities consider the following requirements:

(1) Continuous nuclear logistical support of tactical operations.

(2) Simplicity and uniformity in procedures.

(3) Minimum handling of nuclear ammunition.

(4) Security of classified or critical materiel and installations.

c. The terms "special ammunition load" (SAL), "special ammunition stockage" (SAS), and "special ammunition supply point" (SASP) are defined in AR 320-5.

d. The tactical commander controls the distribution of nuclear ammunition by—

(1) Determining the number of nuclear rounds that will be carried as part of the special ammunition load of organic or attached delivery units that are retained under his control.

(2) Designating any nuclear rounds from his reserve or the reserve of a higher commander desires to have carried in the special ammunition load of a delivery unit that is under the control of a subordinate commander. Thus, the special ammunition load of a given delivery unit may include those weapons available to the organization to which the unit is organic or attached, as well as rounds to be delivered in support of higher, lower, or adjacent echelons.

(3) Arranging for the stockage of nuclear rounds as part of the special ammunition stockage of a special ammunition installation not under his control; directing the stockage of nuclear rounds in special ammunition installations under his control.

e. The positioning of nuclear rounds for security and operational purposes may result in a commander having more or fewer rounds positioned in his command than he is authorized to fire. In the latter case, procedures are established by which the additional rounds can be obtained, or fired, by another command.

f. When the availability of nuclear rounds permits, consideration is given to placing rounds in all nuclear delivery units. This permits dispersal of ammunition. Ammunition is usually positioned at some time during the allocation phase, before authority is given to employ the weapon. In many cases, this permits greater responsiveness after the weapons are released to executing commanders for employment.

g. Replenishment of the special ammunition load and the special ammunition stockage is accomplished by directed individual issue. Because of the limited supply of nuclear rounds and the requirement for varying the location of rounds to meet the changing tactical situation, directed individual replenishment is most feasible.

h. The number of nuclear rounds carried as part of a special ammunition load may vary among similar types of delivery units in the same command.

i. Distribution of nuclear munitions is affected by—

(1) Mission.

(2) Currently released weapons and authorizations to fire.

(3) Allocation, current and anticipated.

(4) Ammunition availability.

(5) Carrying capacity of the delivery units. Consideration is given to the other types of ammunition being carried in the special ammunition load.

(6) Security.

(7) Transportation capability of support units.

j. Nuclear rounds are stored and issued to delivery units by ordnance special ammunition units. The complete nuclear round is issued to nuclear munition delivery users at special ammunition supply points. The details of ordnance ammunition support procedures are contained in FM 9-6-1 and ammunition service in FM 54-8 (Test).

4-14. Tactical Accountability

a. The decisive character of nuclear weapons and their limited availability make detailed recordkeeping necessary. Information pertaining to weapon location, availability, authorization to fire, and expenditure is made available to the members of the tactical operations center and the artillery fire direction center. In addition, the tactical operations center and the artillery fire direction center need information on ammunition readiness status, fire capabilities of nuclear delivery units, and the traveltime between logistical and tactical locations. This information is maintained in a manner that permits ready display to the commander and staff officers. Suggested forms or methods by which needed information can be kept at various staff agencies are discussed in *b* through *d* below. Similar records are kept on other types of special ammunition.

b. Planning information required for employment of nuclear ammunition is shown in figure 4-7. This is an example of an appropriate record and should be modified to meet the needs of the commander at each echelon. They demonstrate use of the sample charts by a corps headquarters. Because fewer types of nuclear rounds are available to a division, the charts at division level should be considerably reduced in size and complexity. Figure 4-7 portrays information on allocations, expenditures, and rounds carried in delivery units and special ammunition supply points. All entries indicate complete-round information, i.e., warhead section or shell and the associated missile and/or the propellant required to deliver the weapon on a target.

c. Information for use in the tactical operations center and the artillery fire direction center, in addition to the two figures described above, is shown in considerable detail in figures 4-8 and 4-9. The charts in these figures may require modification to meet the needs of the commander at each echelon and may, for convenience, be combined to form a single operations board. When a large number of weapons are in the special ammunition load, a separate weapon status chart for each type of delivery system available to the commander (e.g., Honest John, Sergeant, Pershing) should be placed on the operations board together with the air-delivered weapon status chart. The operations board is used in conjunction with the partial nuclear ammunition summary and fire capabilities overlay to visualize the actual distribution of nuclear rounds.

(1) Figure 4-8 accounts for *each* individual nuclear round that the headquarters has retained under its direct control (not those allocated to subordinate commanders). Location and readiness status of each round are indicated. The time and date each round is expended are recorded on this form.

(2) Figure 4-9 indicates the readiness status of each air-delivered weapon allocated to the command. Time and date of expenditure are recorded on this chart.

d. Additional information required to carry out logistical planning is shown on figure 4-10.

NUCLEAR AMMUNITION EXPENDITURE SUMMARY

HQ, 1st Corps
Posted 121800 Jul

	Nuclear ammunition (delivery system/yield)[1]																				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
																Air delivered					
	Total	MRC/0.5 KT	MRC/1 KT	MRC/2 KT	FFR/5 KT	FFR/10 KT	FFR/50 KT	LGM/2 KT	LGM/5 KT	MGM/20 KT	MGM/100 KT	HGM/500 KT	ADM/0.5 KT			Air/10 KT	Air/20 KT	Air/50 KT			Remarks
1st Corps 8-18 July	50	6	3	3	4	6	5	4	5	4	2		3			1	2	2			
Expended to date	15		1	2	1	2	2	3	1	3											
Unexpended	35	6	2	1	3	4	3	1	4	1	2		3			1	2	2			
Allocation of unexpended rounds: Corps targets	4									1	1						1	1			
Allocation of unexpended rounds: 21st Inf Div	6	1			1		1	1	2												For period 11–13 Jul
Allocation of unexpended rounds: 52d Inf Div (Mech)	5	1	1			2	1														
Allocation of unexpended rounds: 28th Armd Div	3	1			1				1												
Allocation of unexpended rounds: Corps res	17	3	1	1	1	2	1		1		1		3			1	1	1			
30th Army Res as of 12 Jul	150	21	12	9	9	14	11	8	13	4	7	6	8			7	8	13			For period through 1 Aug
Distribution of 1st Corps special ammunition load as of 121800 Jul																					
1st Corps in delivery units	17	1	3	1	2	2	2	3	3	1											
1st Corps in SASP	17	5	2	1		1		1	1	1	2		3								
21st Inf Div	6	2			2		2														
52d Inf Div (Mech)	5	1			1	2	1														
28th Armd Div	4	1			1	2															
Total	49	10	5	2	6	7	5	4	4	1	2		3								

8-0176

[1]Delivery system and yields correspond to delivery systems shown in FM 101-31-3.

LEGEND

MRC–Medium-range cannon. MGM–Medium guided missile.
FFR–Free-flight rocket. HGM–Heavy guided missile.
LGM–Light guided missile. ADM–Atomic demolition munition.

Figure 4-7. Example of nuclear ammunition expenditure summary.

Status / Time required (min) / Time delivered			WEAPON READINESS STATUS				
			I	II	III	IV	Remarks
Unit	Yield						

DELIVERY UNIT	TRAVEL TIMES (MINIMUM)

NOTE 1. This chart is maintained on the operations board in the FSE and FDC, together with the air-delivered weapon status chart (fig. 4-9).

2. Under the *Unit* column, more than one delivery unit may be indicated.

3. A separate sheet is used for each delivery system under the operational control of the headquarters.

4. Under the *Time fired* column, the actual time-date that the weapon is fired is listed. This is the official expenditure record for the FSE and the FDC.

5. The four readiness statuses correspond in general to–
   a. I (weapon in shipping container).
   b. II (weapon assembled in rendezvous area).
   c. III (weapon assembled, in firing position).
   d. IV (weapon assembled, checked out, and firing data computed).

6. Under the appropriate weapon readiness status column, the location of each weapon is shown by an abbreviated code. For example:

Location	*Code*
SASP 610	S-610
Bn svc area	Bn
Bn rendezvous area C	C
Bn firing position 4	FP 4

7. Weapons in transit are carried in the *Remarks* column.

Figure 4–8. Example of weapon readiness status and expenditure chart.

AIR-DELIVERED WEAPON STATUS

Delivery system/yield		Time required	Remarks
	Number		

6-0176

NOTE 1. This chart is maintained in the TASE of the TOC.

2. Under the *Delivery system/yield* column, list all the air-delivered weapons available to the headquarters and the number of weapons.

3. Under the *Time required* column, list the delivery time. This includes flight time plus the time required for the aircraft to become airborne.

4. Expenditures are indicated in the *Remarks* column.

Figure 4-9. Example of air-delivered weapon status chart.

4-15. Security of Nuclear Weapons and Delivery Sites

a. Nuclear delivery units and logistical units are comparatively small. The austere organization of the units may not provide sufficient personnel to perform all of the required security missions. The critical primary mission of these units makes them the target of enemy attacks. Commanders augment the units with the security forces necessary to safeguard delivery sites, storage sites, radars, communications facilities, guns, launchers, or weapons.

b. Detailed procedures are established concerning actions to be taken by delivery units to preclude capture of nuclear weapons. SOP specify the circumstances under which the weapon is to be evacuated from the delivery site or is to be destroyed. Destruction means may include firing the weapon into a predetermined disposal area in enemy-held territory or

HQ 1st Corps
Posted 1800 D+2

LOGISTICAL SUMMARY

		Rockets				Missiles						Cannon						Atomic demolition munitions	Remarks	Total in SASP
		Free flight				Light		Medium		Heavy		Short range		Medium range						
Yield																				
SASP	609																			
SASP	610																			
SASP	611																			
Depot	970																			
Overall total in SASP and depots																				

UNITS SUPPORTED BY EACH SASP OR DEPOT

SASP No. 609 1st Corps HQ, 20th Inf Div, and 102d Abn Div	Depot 970 All corps units
SASP No. 610 20th Inf Div	Depot
SASP No. 611 55th Inf Div	
SASP No.	

6-0176

NOTE 1. This chart is maintained by agencies that control and coordinate tactical and logistical operations. It supplements the ammunition expenditure summary shown in figure 4-7. This chart indicates weapons present in the logistical installations.

2. Weapons in transit are shown in the *Remarks* column until their arrival at SASP is confirmed.

Figure 4–10. Example of nuclear ammunition logistical summary.

destroying the nuclear components by demolitions.

4–16. Nuclear Safety

a. To preclude an inadvertent burst, detailed technical safety procedures have been established. These safety procedures, established for peacetime operations, apply to wartime operations to the extent practicable.

(1) Positive measures are established for peacetime operations to—

(*a*) Prevent weapons involved in accidents or incidents (or jettisoned weapons) from producing a nuclear yield.

(*b*) Prevent the deliberate arming, launching, firing, or releasing of weapons, except on execution of emergency war orders or when directed by competent authority.

(*c*) Prevent the inadvertent arming, launching, firing, or releasing of weapons.

(*d*) Provide for adequate security.

(2) Procedures concerning the handling and storage of nuclear weapons are published in the technical manuals and the theater commander's directives that pertain to each nuclear weapon system.

(3) Supervision of weapon handlers is required to insure compliance with established safety procedures.

b. If a nuclear accident occurs, either because of a mistake or because of enemy action, immediate action will reduce the extent of the disaster. SOP specify the actions to be taken by surviving personnel. See FM 3-15 for details.

(1) The accident is reported to the next higher headquarters. This report includes the location and the nature of the accident.

(2) If a surface burst has occurred, fallout will result; a fallout prediction is made and those units affected by the fallout are directed to take the action required.

(3) Control points are established to control entry into areas of high levels of contamination.

(4) Previously organized salvage parties are sent into the area. These parties are trained in decontamination procedures.

c. Enemy duds are reported to the next higher headquarters.

CHAPTER 5

OPERATIONS IN RESIDUAL RADIATION AREAS

5-1. General

a. Nuclear radiation that results from a nuclear explosion and persists longer than 1 minute after burst is termed "residual radiation." Residual radiation can contaminate the airspace over the area of operations, the terrain itself, or both, depending primarily on the height of burst of the weapon. Contamination of the airspace is for a relatively short period of time, and the radiation hazard to aircraft flying within the area is minimal. Residual radiation consists primarily of gamma and beta radiations, both of which present a serious personnel hazard. The gamma radiations are by far the more significant because of their range and penetrating power. Residual radiation can appear on the ground as induced contamination, which is found within a relatively *small* circular pattern around the ground zero; and as fallout, which is found in a large, irregular pattern encompassing the ground zero and extending for long distances downwind from the burst point.

(1) When a weapon is exploded at a height to preclude damage or casualties to ground targets, *neither* induced contamination *nor* fallout of tactical significance occurs. However, if rain (or snow) falls through the nuclear cloud, tactically significant *fallout* may result.

(2) When the height of burst is lowered below that indicated above to produce damage or casualties on the ground, but is kept above the fallout-safe height, induced contamination occurs. Fallout considerations are the same as those in (1) above.

(3) When a surface burst is employed, both induced contamination and significant fallout result. The fallout pattern can be expected to overlap and to mask the entire induced contamination pattern.

(4) Shallow subsurface bursts produce both induced contamination and fallout patterns on the ground.

b. Induced contamination and fallout have certain characteristics in common.

(1) Both persist for relatively long periods.

(2) Fallout consists largely of very fine particles and covers large areas. Induced contamination may be found to a depth of about one-half meter. For these reasons, the areas affected by both types of radiation are difficult to decontaminate.

(3) The size, shape, and location of fallout patterns are sensitive primarily to the wind structure. The size and intensity of the area of induced contamination are extremely sensitive to the variability of the soil composition. For these reasons, areas affected by both types of radiation are difficult to predict; However, fallout prediction is by far the more difficult and important problem.

c. The large areas contaminated by fallout pose an operational problem of great importance. Potentially, fallout may extend to greater distances and cause more casualties than any other nuclear weapon effect. It exerts an influence on the battlefield for a considerable time after a detonation. Induced contamination is relatively *limited in area*, and *minor* tactical changes normally can be made to avoid any serious effects.

d. The biological response of humans to residual radiation is essentially the same as their response to initial radiation. The total dose of radiation absorbed by an individual is the sum of the initial radiation doses and the residual radiation doses he has received. Biological response to radiation is discussed in detail in paragraph 2-22.

5-2. Induced Contamination

a. All radioactive materials decay. The rate at which this decay takes place depends on the soil elements themselves. Some (e.g., sodium) decay slowly and others (e.g., aluminum) decay rapidly. This decay rate, measured in terms of "half-life," and the element's gamma radiation intensity determine the significance of the induced radiation hazard. The distance to which a 2-rad-per-hour dose rate extends 1 hour after burst is considered the limit of significant induced activity. Estimates of the extent of the 2-rad-per-hour contour, are contained in table B-III-1, FM 101-31-2 and chapter 18, FM 101-31-3.

b. Whenever a nuclear attack is being planned, the nuclear weapon employment officer advises the commander and the staff of the possible hazard of induced contamination. After the attack, a radiological contamination chart is made from the reports of radiological survey teams. In comparison with other nuclear weapon effects, however, induced radiation *does not pose a threat* of major military significance.

(1) It may be extremely hazardous for troops to enter and to stay in an area of induced contamination. Because of the great destruction near the ground zero, where induced contamination may be found, there is seldom a requirement for troops to enter and stay in the area. In the event occupancy is necessary, radiation is monitored to insure that allowable total doses are not exceeded.

(2) Thirty minutes after burst, troops in vehicles may usually pass through the ground zero and foot troops may usually pass within 300 meters of the ground zero without undue radiation risk. (It is emphasized that this is true only if the burst was at sufficient altitude to preclude fallout. The area around GZ 30 minutes after fallout producing bursts will be subject to extremely high dose rates.)

The area of induced contamination is relatively *small*, and it should be possible to avoid it or to traverse it rapidly.

5-3. Fallout

☆*a.* Radioactive fallout also decays. The decay rate from a single weapon can be determined fairly accurately by using the M1 radiac calculator. For a quick estimate of fallout decay, the intensity can be considered to decrease by a factor of ten as the time after burst increases by multiples of 7. Thus a 50-rad-per-hour dose rate (measured at H+1 hour) decays to a five-rad-per-hour dose rate in 7 hours and to less than one-half rad-per-hour dose rate at H+49 hours.

b. Use of fallout is discussed in paragraph 4-10.

c. Reduced to fundamentals, the major aspects of fallout deposition are as follows:

(1) Fallout is formed whenever the nuclear fireball intersects the ground.

(2) The heavier fallout particles start reaching the ground around the ground zero within a few minutes after burst. The lighter particles reach the ground farther downwind at later times. Figure 5-1 illustrates how total dose may vary with time and distance.

(3) The size, shape, and location of the areas contaminated by fallout depend largely on the winds that blow the particles that rise with the nuclear cloud and then fall back to earth. Changing wind directions can subject some locations to long periods of fallout deposition.

(4) Greatest intensity is usually close to the ground zero, but high-intensity "hotspots" and low-intensity "areas" may occur throughout the pattern because of winds or rain.

d. The total radiation dose absorbed by an individual is a function of radiation intensity, exposure time, and protection.

e. Residual radiation is absorbed or reflected in the same manner as prompt gamma radiation. See paragraph 2-21*b* for shielding considerations.

f. FM 3-12 provides procedures to compute permissible exposure times and total doses in fallout areas. The M1 radiac calculator can also be used to compute total doses and exposure times in single weapon fallout areas.

5-4. Prediction of Fallout Areas

(This paragraph is based on STANAG No. 2103.)

a. A tactical fallout prediction system must be a compromise between speed and simplicity, on the one hand; and the time-consuming complexity that increases accuracy, on the other. The present U.S. Army method of predicting fallout gives only a warning sector, somewhere within which most of the fallout is expected to occur.

b. The U.S. Army and U.S. Marine Corps method of fallout prediction is explained in TM 3-210. The prediction results in portrayal of an area that is expected to contain most of the significant fallout. A detailed prediction is prepared in the tactical operations center, based on the best available weather and weapon data. Brigade and lower units use the M5 fallout predictor and effective wind message to estimate the hazard area; the M5 predictor is applied using less precise data. Both predictions present a *graphical* portrayal of the expected hazard. The hazard area is subdivided into—

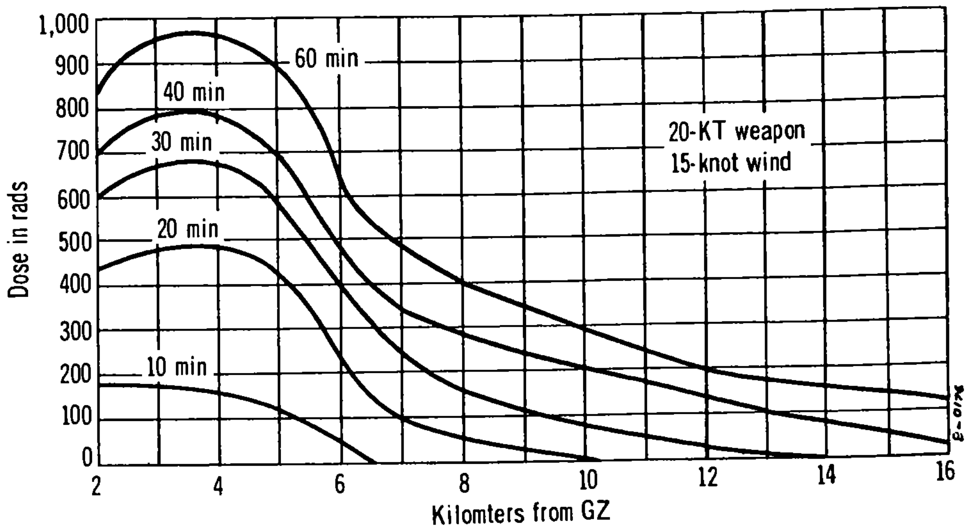

Figure 5-1. Total dose variation as a function of time after bursts and distance from the burst.

(1) An area within which countermeasures may have to be taken immediately (divided into two separately defined sub-areas) ; and

(2) An area in which early, but not immediate, action may have to be taken to counter the threat of unacceptable doses.

c. The basic inaccuracies in fallout prediction permit this method to be used in depicting suspect areas for early monitoring and survey, as well as for planning movement of units, but *not as a basis for executing operational moves* (para 5-5*a*(1)). The method also permits prediction of the areas outside which friendly troops are likely to have relative immunity from the fallout hazard.

d. In an active nuclear war, it is reasonable to expect fallout at a given location occasionally to be caused by more than one nuclear burst, thereby causing multiple overlapping fallout patterns. See FM 3-12 and TM 3-210 for the proper technique to handle such situations.

★5-5. Basis for Standing Operating Procedures for Operations in Fallout Areas

a. Command decisions in any fallout situation are based on consideration of two opposing factors: the demands of the tactical situation and the hazards due to radiation. At one extreme, the total energies of the unit are directed toward keeping the radiation exposure at a minimum. At the other extreme, the demands of the tactical situation are clearly dominant.

(1) *Radiation hazard dominant.* In general, two courses of action are considered: early movement from the fallout area and remaining in position.

(*a*) *Early movement.*

1. When air or surface transport means are available, evacuation from the area as soon as possible normally is the best course of action.

2. When the shielding provided by the exit means is approximately equal to or better than that available in the position (and in the absence of air evacuation means), movement from the area is accomplished as soon as the minimum-dose exit route can be determined. (See FM 3-12 for details.)

3. Fallout predictions are *not* sufficiently accurate to be used as a sole basis for such moves. Therefore, movements normally are based on measured dose rates and dosimeter readings obtained *after* the fallout has begun. From such readings, the direction of decreasing intensities and the limits of the fallout pattern nearest the unit are determined. From this, a minimum-dose exit route is selected. A method for determining the optimum time for exit of fallout areas is given in FM 3-12.

4. All available shielding measures are taken within the position until evacuation or movement has begun.

(*b*) *Remaining in position.* When the total dose expected in the position is significantly less than that which would occur by moving, the best solution is to remain in position for approximately 6 hours after the burst, at which time movement from the pattern can be made or decontamination operations can be begun.

(2) *Tactical demand dominant.*

(*a*) When the tactical demand clearly governs, the unit continues to place primary emphasis on the accomplishment of its mission. The unit takes action whenever possible to keep radiation exposure to a minimum. These actions usually consist of decontamination and the use of available shielding.

(*b*) Decisions to shift emphasis toward countermeasures against radiation are dependent on a capability to predict with reasonable accuracy the times at which the crucial radiation doses will be reached. Such predictions can be made when the peak dose rate and the time to peak (in minutes after burst) are known. When such predictions cannot be made because unit survey meters have gone off scale, it can be assumed that the unit will be exposed to incapacitating radiation doses within a few minutes unless immediate countermeasures are taken.

Table 6-1. Types and Degrees of Protection for Personnel Against Nuclear Weapons Effects

Type of protection	*Degree of protection*				
		Initial effects		*Residual radiation*	
	Blast	*Thermal*	*Initial radiation*	*Induced*	*Fallout*
In the open	None	None to fair. Clothing protects against heat, depending on nature of material and number of layers. Air between layers of clothing provides insulation.	None	None	None.
Stone, brick, or concrete walls.	Fair, depending on material, thickness, and type of construction.	Excellent against direct rays. None against rays reflected to back side of wall.	Some from direct radiation. None from scattered radiation.	None	None.
Ditches, slit trenches.	Good, depending on orientation relative to the ground zero.	Good, depending on depth and orientation. Rays can be reflected to inside.	Good, depending on depth and orientation. Radiation can be scattered to inside.	None	None against entry of fallout particles. Fair against radiation from surrounding area. Decontamination of ditches is difficult.
Culverts	Good, depending on orientation relative to the ground zero, depth, and construction.	Excellent, depending on orientation. Rays can be reflected into openings.	Excellent, depending on orientation and depth. Radiation can be scattered into openings.	Good, depending on depth and closing of openings with earth, sandbags, and other material.	Good, provided openings are closed with earth or other material and continuous decontamination is practiced.
Ravines and gullies	Fair	Excellent against direct rays. Some thermal may be scattered.	Some from direct radiation. None from scattered radiation.	None to fair	None to fair.
Open foxholes and trenches.	Good	Excellent against direct rays. Thermal can be reflected into foxhole.	Excellent against direct radiation. None from scattered radiation.	Questionable. Degree of protection depends on removing radioactive soil from surrounding area and inside foxhole or trench.	Excellent, provided foxhole is covered with poncho, shelter half, or other material to exclude fallout and particles; decontamination is continuous after fallout is complete.

Covered foxholes and trenches (1-meter earth cover).	Excellent	Excellent	Excellent	Protection is better than that in open foxholes. More personnel will survive initial effects than those in open foxholes. Scraping 2 inches from the surface inside foxhole will drastically reduce induced contamination inside foxhole.	Excellent, provided decontamination is continuous after fallout is complete.
Emplacements or shelters (1-meter earth cover).	Excellent	Excellent	Excellent	Questionable. See above.	Excellent.
Built-up areas (outdoors).	None to fair. Depends on distance from the ground zero, type of structure, reflection of blast wave, and missiles.	None to excellent, depending on orientation with the ground zero.	None to excellent, depending on orientation with the ground zero.	None to fair	None from falling particles. Fair after cessation of fallout.
Residential buildings (one-family frame):					
Upper floors	None to fair	Excellent from direct radiation. None from secondary fires.	None	Fair	None to fair.
Basements	Good from direct blast. Hazard of collapse of upper floors into basement.	Excellent	Good	Excellent	Excellent.
Apartments and office buildings:					
Upper floors	Fair	Excellent	None to fair	Excellent	Excellent.
Basements	Good	Excellent	Good	Excellent	Excellent.
Light-metal industrial buildings.	None	Good	None	Fair	Fair.
Tents	None	Good	None	None	None.
Forests	None	Fair to good, depending on canopy cover, density of stand, and location of individual in respect to edge of forest toward the ground zero.	None	None	None. Fallout deposited on foliage may increase radiation effects.

Table 6-1. Types and Degrees of Protection for Personnel Against Nuclear Weapon Effects—Continued

Type of protection	*Degree of protection*				
	Initial effects			*Residual radiation*	
	Blast	*Thermal*	*Initial radiation*	*Induced*	*Fallout*
Wheeled vehicles	None	None to fair	None	Shielding is fair. Mobility will reduce exposure time when leaving or crossing the area.	Shielding is fair. Mobility will reduce exposure time when leaving or crossing the area.
Armored carriers	Good	Excellent	Fair	Shielding is fair. Mobility will reduce exposure time when leaving or crossing the area.	Shielding is fair. Mobility will reduce exposure time when leaving or crossing the area.
Tanks	Excellent	Excellent	Excellent	Shielding is excellent. Mobility will reduce exposure time when leaving or crossing the area.	Shielding is excellent. Mobility will reduce exposure time when leaving or crossing the area.

APPENDIX A

REFERENCES

A-1. Army Regulations

AR 40-14	Control and Recording Procedures, Occupational Exposure to Ionizing Radiation.
AR 50-2	Nuclear Weapon Accident and Incident Control (NAIC).
AR 55-203	Movement of Nuclear Weapons Components and Nuclear Weapons Material.
AR 95-55	Nuclear Weapon Jettison.
AR 220-58	Organization and Training for Chemical, Biological, and Radiological (CBR) Operations.
AR 320-5	Dictionary of United States Army Terms (Short Title: AD).
AR 320-50	Authorized Abbreviations and Brevity Codes.
(O) AR 700-65	Nuclear Weapons and Nuclear Weapons Material.

A-2. Field Manuals

FM 310	Employment of Chemical and Biological Agents.
(S) FM 3-10A	Employment of Biological Agents (U).
(C) FM 3-10B	Employment of Chemical Agents (U).
FM 3-12	Operational Aspects of Radiological Defense.
FM 3-15	Nuclear Accident Contamination Control.
FM 5-26	Employment of Atomic Demolition Munitions (ADM)
FM 6-20-1	Field Artillery Tactics.
FM 6-20-2	Field Artillery Techniques.
(S) FM 9-2A	Special Ammunition Logistical Data (Classified Data) (U).
FM 9-6-1 (Test)	Ammunition Service in the Theater of Operations TASTA-70.
FM 21-30	Military Symbols.
FM 21-40	Chemical, Biological, and Nuclear Defense.
FM 21-41	Soldier's Handbook for Defense Against Chemical and Biological Operations and Nuclear Warfare.
FM 31-10	Barriers and Denial Operations.
(S) FM 44-1A	U.S. Army Air Defense Employment (U).
FM 54-8 (Test)	The Administrative Support Theater Army TASTA-70.
FM 61-100	The Division.
(S) FM 101-31-2	Staff Officers' Field Manual; Nuclear Weapons Employment Effects Data (Classified) (U).
FM 101-31-3	Staff Officers' Field Manual; Nuclear Weapons Employment Effects Data (Unclassified).
FM 105-5	Maneuver Control.
(C) FM 105-6-1	Nuclear Play Calculator (U).
FM 105-6-2	Nuclear Play Calculator.

FM 105-6-3	Nuclear Play Calculator Aggressor.

A-3. Technical Manuals

TM 3-210	Fallout Prediction.
TM 3-220	Chemical, Biological, and Radiological (CBR) Decontamination.
TM 5-225	Radiological and Disaster Recovery at Fixed Military Installation.
TM 5-311	Military Protective Construction (Nuclear Warfare and Chemical and Biological Operations).
(C) TM 23-200	Capabilities of Nuclear Weapons (U).
TM 55-602	Movements of Special Freight.

A-4. Other Publications

DA Pam 39-3	Nuclear Weapons.
JCS Pub 1	Dictionary of United States Military Terms for Joint Usage (Short Title: JD).
TB 385-2	Nuclear Weapons Firefighting Procedures.
TB CML 92	Calculator Set, Nuclear M28.
TB CML 120	Area Predictor Radiological Fallout, M5.
TC 3-15	Prediction of Fallout from Atomic Demolition Munitions (ADM).

SHORT RANGE CANNON
1.0 KT

SAFETY DISTANCE TABLE

(Distances in meters)

RANGE	TROOP SAFETY: UNWARNED EXPOSED NEG	TROOP SAFETY: UNWARNED EXPOSED EMER	TROOP SAFETY: WARNED EXPOSED NEG	TROOP SAFETY: WARNED EXPOSED EMER	TROOP SAFETY: WARNED PROTECTED NEG	TROOP SAFETY: WARNED PROTECTED EMER	PRECLUDE DAMAGE: MOD DAMAGE TO FIXED BRIDGES	PRECLUDE DAMAGE: LIGHT DAMAGE TO BUILDINGS	PRECLUDE DAMAGE: LIGHT A/C IN FLIGHT	PRECLUDE OBSTACLES: TREE BLOWDOWN DECIDU-OUS	PRECLUDE OBSTACLES: TREE BLOWDOWN CONIFER-OUS	PRECLUDE OBSTACLES: FIRES DRY FUEL	PRECLUDE OBSTACLES: FIRES GREEN FUEL
2000	1900	1400	1900	1400	1600	1200	300	1300	2300	400	400	1000	700
3000	1900	1400	1900	1400	1600	1200	300	1400	2300	400	400	1000	700
4000	1900	1500	1900	1500	1600	1200	400	1400	2400	400	400	1000	700
5000	1900	1500	1900	1500	1700	1200	400	1500	2500	400	400	1000	700
6000	2000	1500	2000	1500	1700	1200	400	1500	2500	500	500	1100	700
7000	2000	1500	2000	1500	1700	1300	400	1500	2600	500	500	1100	700
8000	2000	1500	2000	1500	1700	1300	400	1600	2700	500	500	1100	700
9000	2000	1500	2000	1500	1700	1300	400	1600	2700	500	500	1100	700
10000	2000	1600	2000	1600	1700	1300	400	1700	2800	500	500	1100	700

Figure B–5. Example of portions of the safety distance table.

SHORT RANGE CANNON
1.0 KT

PROMPT CASUALTIES TO EXPOSED PERSONNEL
LOW AIRBURST

COVERAGE TABLE
(Distances in meters)

RANGE	EFFECTIVENESS								ACCURACY DATA				
	RADIUS OF TARGET								PROB. MIN. RD	CD 90	CEP	HOB	PEH
	600	700	800	900	1000	1100	1200	1300					
2000	.9/.9	.7/.7	.6/.6	.5/.5	.4/.4	.3/.3	.3/.3	.2/.2	602	25	14	49	5
3000	.9/.9	.7/.7	.6/.6	.5/.5	.4/.4	.3/.3	.3/.3	.2/.2	601	38	21	55	8
4000	.9/.9	.7/.7	.6/.6	.5/.5	.4/.4	.3/.3	.3/.3	.2/.2	599	51	28	62	10
5000	.9/.9	.7/.7	.6/.6	.5/.5	.4/.4	.3/.3	.3/.3	.2/.2	597	64	35	73	13
6000	.8/.9	.7/.7	.6/.6	.5/.5	.4/.4	.3/.3	.3/.3	.2/.2	595	77	42	80	15
7000	.8/.9	.7/.7	.6/.6	.5/.5	.4/.4	.3/.3	.3/.3	.2/.2	592	90	49	90	18
8000	.8/.9	.7/.7	.6/.6	.5/.5	.4/.4	.3/.3	.3/.3	.2/.2	590	102	56	97	20
9000	.8/.8	.7/.7	.6/.6	.4/.5	.4/.4	.3/.3	.2/.3	.2/.2	586	116	63	108	23
10000	.8/.8	.7/.7	.6/.6	.4/.5	.4/.4	.3/.3	.2/.3	.2/.2	583	128	70	115	25

Figure B-6. Example of coverage table.

SHORT RANGE CANNON
1.0 KT

EFFECTS TABLE
(Distances in meters)

HOB	PERSONNEL CASUALTIES IN APC'S PRMPT	PERSONNEL CASUALTIES IN APC'S DELAY	PERSONNEL CASUALTIES IN MDM TANKS PRMPT	PERSONNEL CASUALTIES IN MDM TANKS DELAY	PERSONNEL CASUALTIES IN EARTH SHELTERS PRMPT	PERSONNEL CASUALTIES IN EARTH SHELTERS DELAY	PERSONNEL CASUALTIES IN MULTI-STORY APARTMENTS PRMPT	PERSONNEL CASUALTIES IN MULTI-STORY APARTMENTS DELAY	PERSONNEL CASUALTIES IN FRAME BUILDINGS PRMPT	PERSONNEL CASUALTIES IN FRAME BUILDINGS DELAY	SEV DAM TO SUP DEP	MOD DAM TO PKD HEL	SEV DAM TO ELEC EQUIP	SEV DAM TO OPEN GRID RADAR ANT	SEVERE DAMAGE TO BRIDGES FIXED	SEVERE DAMAGE TO BRIDGES FLOAT
550	110	530	0	310	0	0	220	580	260	600	0	1040	0	0	0	0
525	200	560	0	350	0	0	270	600	300	620	0	1070	0	0	0	0
500	250	580	0	380	0	0	320	630	340	640	0	1110	0	0	0	0
475	300	600	0	410	0	0	350	640	380	660	0	1160	0	0	0	0
450	330	620	0	440	0	0	380	660	420	680	0	1330	0	0	0	0
425	360	640	140	460	0	0	410	680	440	690	0	1410	0	0	0	0
400	390	650	200	490	0	130	440	690	520	710	0	1430	0	0	0	0
375	420	670	240	500	0	190	460	710	580	720	0	1420	0	0	0	0
350	440	680	280	520	0	230	480	720	630	730	0	1410	0	0	0	0
325	460	690	310	540	0	270	490	730	660	740	0	1390	0	710	0	0
300	470	700	330	550	0	290	510	740	680	750	0	1360	0	720	0	0
275	490	710	350	570	10	320	540	750	700	760	0	1330	0	710	0	0
250	500	720	370	580	120	340	550	760	700	770	0	1310	40	710	0	0
225	510	730	390	590	160	360	550	770	690	780	0	1280	90	690	0	0
200	520	740	400	600	190	370	560	780	670	790	0	1250	130	670	0	0
175	530	740	410	600	210	380	570	780	650	790	0	1210	160	640	0	0
150	540	750	420	610	230	390	570	790	630	800	50	1170	180	620	0	130
125	550	750	430	620	250	400	580	790	600	800	80	1130	190	600	180	140
100	550	760	440	620	260	410	580	790	590	810	100	1090	210	570	180	170
75	560	760	440	620	260	410	590	800	600	810	120	1050	220	540	180	180
50	560	760	440	630	270	420	590	800	600	810	130	1020	230	520	170	170
25	520	720	410	580	240	380	550	760	560	770	130	980	220	490	150	150
0	520	720	410	580	240	380	550	760	560	770	80	930	180	460	140	140

Figure B-7. Example of effects table.

ANNEX B-III
LIMITING REQUIREMENTS

B-III-1. General

Restrictions placed on the employment of nuclear weapons are referred to as "limiting requirements." These limiting requirements are imposed to avoid undesirable effects caused by nuclear weapons in the form of—

a. Casualties to friendly troops.

b. Creation of obstacles to movement, to include fire areas.

c. Damage to installations desired for the use of friendly troops, such as bridges and buildings.

d. Damage to friendly light aircraft in flight.

B-III-2. Troop Safety

(This paragraph is based on SOLOG No. 89.)

a. In comparison with the use of nonnuclear weapons, the use of nuclear weapons in close tactical support involves a much greater degree of risk to the safety of friendly troops.

b. Troop safety may influence the selection of the yield, the delivery system, the desired ground zero, the time of burst, and the scheme of maneuver. When the SOP or command guidance concerning troop safety cannot be met, the following actions may be taken:

(1) Move the desired ground zero.
(2) Use a more accurate delivery means.
(3) Use a lower yield weapon(s).
(4) Withdraw troops.
(5) Accept less coverage.
(6) Accept a higher degree of risk of damaging friendly units.
(7) Increase the protection of friendly troops.
(8) Use other forms of combat power, such as nonnuclear fires or maneuver elements.

c. The nuclear weapon employment officer uses a minimum safe distance (MSD) to make troop safety calculations. The minimum safe distance considers both the delivery error and the distance to which certain weapon effects extend. The following definitions are used in determining the appropriate minimum safe distance:

(1) There are *three degrees of risk* associated with troop safety considerations—*negligible, moderate, and emergency.*

(*a*) At a *negligible risk* distance, troops will receive less than a 5-rad dose and are completely safe from militarily significant thermal radiation. However they may experience a temporary loss of vision (dazzle). A negligible risk is acceptable in all cases. *Negligible risk should not be exceeded unless significant advantages will be gained.*

(*b*) A *moderate risk* condition normally is used only for those nuclear weapon yields where radiation is the governing troop safety criteria. A moderate risk is considered acceptable in close support operations; for example, to create a gap in enemy forward positions or to halt an enemy attack. A moderate risk should not be exceeded if troops are expected to operate at full efficiency after a friendly burst.

(*c*) At an *emergency risk* distance, the anticipated effects levels may cause some temporary shock and a few casualties. A number of long-term casualties may be produced if personnel have been previously exposed to nuclear radiation. Personnel may be temporarily incapacitated from the blast wave. Collapsing foxholes may cause some casualties. For these reasons, there may be a decrease in the combat efficiency of the unit. *An emergency risk should be accepted only when* *it is absolutely necessary to gain a significant military advantage.*

(2) Closely associated with the degrees of risk is the *vulnerability* of the individual soldier. The danger to an individual from a nuclear explosion depends principally on the degree to which he is protected from the weapon effects. For example, a man who is well protected can safely be much closer to the ground zero than can be a man in the open. The degree of protection of the unit is considered in target analysis to be dependent on the amount of advance warning the unit has received. One or more of the following three conditions of *personnel vulnerability* can be expected at the time of burst: unwarned, exposed; warned, exposed; or warned, protected.

(*a*) *Unwarned, exposed* persons are assumed to be standing in the open at burst time, but have dropped to a prone position by the time the blast wave arrives. They are expected to have areas of bare skin exposed to direct thermal radiation, and some personnel may suffer dazzle. For example, such a condition can be expected to prevail in an offensive situation when the majority of the attacking infantry are in the open and a warning of the burst has not been disseminated.

(*b*) *Warned, exposed* persons are assumed to be prone on open ground, with all skin areas covered and with an overall thermal protection at least equal to that provided by a two-layer summer uniform. For example, such a condition may prevail when a nuclear weapon is employed against a target of opportunity during an attack and sufficient time exists to broadcast a warning; troops have been warned, but do not have time to dig foxholes.

(*c*) *Warned, protected* persons are assumed to have some protection against heat, blast, and radiation. The assumed degree of protection is that protection offered to personnel who are in "buttoned-up" tanks or crouched in foxholes with improvised overhead thermal shielding. When only a lesser degree of protection is available (e.g., only tracked carriers are available), personnel cannot be considered warned protected. The target analyst would consider such personnel as exposed. A warned, protected condition is generally expected to prevail when nuclear weapons are used in a preparation prior to an attack.

(*d*) It should be noted that there is no category for *unwarned, protected.* Although protection may be available to personnel, it cannot be assured that they will be taking advantage of it unless they are warned of an impending burst.

(3) For each *combination* of degree of risk and condition of personnel vulnerability, there is an associated "risk distance" known as the radius of safety. It is the horizontal distance from the *actual* ground zero *beyond which* the weapon effects are acceptable. Because a round may burst at the end of the dispersion pattern nearest to friendly troops, a buffer distance is added to the radius of safety. The buffer distance provides a very high assurance (99 percent) that unacceptable weapon effects will not reach friendly troops. The size of the buffer distance is dependent on the horizontal delivery error at the applicable range. The sum of the radius of safety and the buffer distance is the minimum safe distance shown in the safety distance tables in FM 101-31-2 and (ch 18) FM 101-31-3. The minimum safe distance value listed is the minimum distance in meters that must separate friendly troops from the desired ground zero

FREE FLIGHT ROCKET
10.0 KT

TROOP SAFETY

RANGE	UNWARNED EXPOSED		WARNED EXPOSED		WARNED PROTECTED	
	NEG	EMER	NEG	EMER	NEG	EMER
10000	4800	3900	2800	2500	2400	1900
11000	4900	3900	2800	2500	2500	2000
12000	4900	3900	2900	2500	2500	2000
13000	4900	4000	2900	2600	2500	2000
14000	5000	4000	2900	2600	2600	2100
15000	5000	4000	3000	2600	2600	2100
16000	5000	4100	3000	2700	2600	2100
17000	5100	4100	3000	2700	2700	2200
18000	5100	4100	3100	2700	2700	2200
19000	5100	4200	3100	2800	2700	2200
20000	5200	4200	3100	2800	2800	2300
21000	5200	4200	3200	2800	2800	2300
22000	5200	4300	3200	2900	2800	2300
23000	5300	4300	3200	2900	2900	2300
24000	5300	4300	3300	2900	2900	2400
25000	5300	4400	3300	3000	2900	2400
26000	5400	4400	3300	3000	2900	2400
27000	5400	4400	3300	3000	3000	2500
28000	5400	4500	3400	3000	3000	2500
29000	5500	4500	3400	3100	3000	2500
30000	5500	4500	3400	3100	3100	2500

Figure B-III-1. Example of troop safety portion (range-dependent system) of safety distance table.

so that the specified degree of risk *will not be exceeded.* If troops are farther from the desired ground zero than the distance listed, there is no troop safety problem.

d. In determining the expected degree of risk to which troops will be exposed, the target analyst needs to know the location and radiation exposure history of friendly elements and the degree of protection they are expected to have at the time of burst.

B-III-3. Determination of Minimum Safe Distance for an Airburst

a. The negligible and emergency risk distances for the three vulnerability conditions (para B-III-2*c*(2)) are listed in the safety distance tables. These tables are located in the target coverage tables for airburst, under the appropriate weapon system and yield, in FM 101-31-2 and FM 101-31-3. There are two types of safety distance tables—range-dependent system and range-independent system. An example of a range-dependent system table in the free-flight rocket with a 10-kiloton yield (FFR/10 KT). A portion of this table is reproduced in figure B-III-1. An example of a range-independent system table is the light guided missile with a 10-kiloton yield (LGM/10 KT). A portion of this table is reproduced in figure B-III-2.

b. To use figure B-III-1, enter with the target range rounded off to the nearest 1,000 meters. (Do not interpolate. If the target range lies *exactly halfway* between two listed ranges, enter at the largest listed range (e.g., if the target range is 10,500 meters, use an entry

LIGHT GUIDED MISSILE

TROOP SAFETY

YIELD	UNWARNED EXPOSED		WARNED EXPOSED		WARNED PROTECTED	
	NEG	EMER	NEG	EMER	NEG	EMER
2 KT	2200	1700	2200	1700	1900	1500
5 KT	3100	2500	2400	1900	2100	1600
10 KT	4700	3700	2700	2300	2300	1800
20 KT	6900	5400	3700	3200	2500	2000

Figure B–III–2. Example of troop safety portion (range-independent system) of safety distance table.

range of 11,000 meters). If the target range is other than exactly halfway between two listed ranges, round off upward or downward to the next higher or lower listed range (e.g., if the target range is 10,400 meters, use an entry range of 10,000 meters; if the target range is 10,600 meters, use an entry range of 11,000 meters).) Read the minimum safe distance opposite the entry range under the vulnerability condition and degree of risk specified. Examples of the use of the troop safety portion of the safety distance table are as follows:

(1) *Example 1* (*range-dependent system*).

(*a*) *Given*: Delivery system—free-flight rocket
Yield = 10 KT
Range = 24,600 meters
HOB—low air
Vulnerability condition—unwarned, exposed personnel
Degree of risk—negligible.

(*b*) *Find:* The MSD.

(*c*) *Solution:* Enter figure B–III–1 with the range of 25,000 meters. Moving to the right, under the column for unwarned, exposed personnel, negligible risk, read the MSD as 5,300 meters. This is the minimum distance that must separate the DGZ and friendly troops so that the troops will be subjected to no more than a negligible risk.

(2) *Example 2* (*range-independent system*). To use figure B–III–2, enter with the weapon yield (10 KT in this case) and read the MSD under the appropriate column for the vulnerability condition and the degree of risk specified (4,700 meters in this case).

B–III–4. Preclusion of Obstacles

a. The large amount of destructive energy released from a single nuclear detonation creates serious obstacles to the movement of friendly troops. These obstacles take the form of neutron-induced gamma activity (NIGA), fallout, tree blowdown, and fires.

b. The preclusion of these obstacles can influence the selection of the yield, the delivery system, and the desired ground zero. When the SOP or command guidance concerning the preclusion of obstacles cannot be met, the following actions may be taken:

(1) Move the desired ground zero.

(2) Use a more accurate delivery means.

(3) Use lower yield weapon(s).

(4) Accept less coverage.

(5) Accept a higher probability of producing obstacles.

(6) Use other forms of combat power, such as nonnuclear fires or maneuver elements.

★ *c.* The nuclear weapon employment officer uses a least separation distance (LSD) to make preclusion-of-obstacle calculations. Both the delivery error and the distance to which certain weapon effects extend are incorporated in the least separation distance. If the least separation distance extends from the desired ground zero to the point of interest, there is better than a 90-percent probability that obstacles will not be produced at that point.

d. A discussion of obstacles to the movement of friendly troops is included in (1) through (5) below.

(1) *Neutron-induced gamma activity.* When a nuclear detonation takes place in the proximity of the earth's surface, free neutrons from this detonation bombard the elements in the soil, making some of them radioactive. The subsequent decay of these radioactive elements produces the residual nuclear radiation known as neutron-induced gamma activity, and is a definite hazard to troops occupying or passing through the area. The distance to which this obstacle-producing effect will extend is extremely variable and cannot be predicted to within a reasonable degree of accuracy. Therefore, the areas within the distances shown in table B-III-1 are considered hazard areas and require monitoring for accurate information on radiation intensity and size of the pattern.

Table B-III-1. Estimated 2-Rad-Per-Hour Radius of Induced Contamination

Yield	*Horizontal radius (meters)*
1 KT	400
10 KT	700
100 KT	1,000
1 MT	1,400

(2) *Fallout.* Militarily significant fallout from surface or near-surface bursts is also a nuclear radiation hazard to troops who must occupy or cross these contaminated areas. The distance to which fallout will extend can be estimated using the procedures outlined in TM 3-210. The actual location of fallout within the predicted area of hazard must be ascertained by radiological monitoring and survey.

(3) *Tree blowdown.* Uprooted trees, broken crowns, and fallen limbs can present a considerable obstacle to foot and wheeled- and tracked-vehicle movement. However, the distances to which tree blowdown will occur is predictable, and these distances are listed in the safety distance tables included in FM 101-31-2 and FM 101-31-3 under the columns for preclusion of obstacles (fig. B-III-3). These distances are the least separation distances required between the desired ground zero and the point at which tree blowdown is to be precluded. For the purpose of determining the least separation distance for tree blowdown, trees are classified into two groups.

(*a*) *Deciduous.* Deciduous trees lose their leaves at the end of the growing season.

(*b*) *Coniferous.* Coniferous trees are of the evergreen family.

Knowing the type of trees in the area of interest, the target analyst can enter the appropriate safety distance table for the delivery system and yield (at the nearest listed range) and extract the least separation distance from the proper column for tree blowdown. Because the least separation distance is not dependent on the target category, any of the safety distance tables for the delivery system, yield, and height of burst may be used ((5) below).

(4) *Fires.* The thermal energy emitted from a nuclear detonation is capable of starting fires at considerable distances from the ground zero. These distances are predictable for normal atmospheric conditions. However, the distance to which these fires, once started, will extend is dependent on terrain, type of fuel, wind velocity, and other parameters and cannot be predicted. The least separation distances required to preclude ignition of fires are listed in the safety distance tables in FM 101-31-2 and FM 101-31-3 under the columns for preclusion of obstacles (fig. B-III-3). For the purpose of determining the least separation distances for fires, fuels are classified into two groups: dry and green (see descriptions in FM 101-31-2 and FM 101-31-3). Knowing the type of fuel in the area of interest, the target analyst can enter the safety distance table for the appropriate delivery system and yield (at the nearest listed range) and extract the least separation distance from the proper column for fires.

FREE FLIGHT ROCKET
10.0 KT

RANGE	PRECLUDE DAMAGE: MOD DAMAGE TO FIXED BRIDGES	PRECLUDE DAMAGE: LIGHT DAMAGE TO BUILDINGS	PRECLUDE DAMAGE: LIGHT A/C IN FLIGHT	PRECLUDE OBSTACLES: TREE BLOWDOWN DECIDUOUS	PRECLUDE OBSTACLES: TREE BLOWDOWN CONIFEROUS	PRECLUDE OBSTACLES: FIRES DRY FUEL	PRECLUDE OBSTACLES: FIRES GREEN FUEL
15000	1100	4000	6700	1400	1300	3200	2100
16000	1100	4100	6800	1400	1300	3200	2100
17000	1100	4200	6900	1400	1300	3200	2100
18000	1100	4200	6900	1400	1400	3200	2200
19000	1200	4300	7000	1500	1400	3300	2200
20000	1200	4400	7100	1500	1400	3300	2200
21000	1200	4400	7200	1500	1400	3300	2200
22000	1200	4500	7300	1500	1400	3300	2200
23000	1200	4500	7300	1500	1500	3300	2200
24000	1200	4600	7400	1500	1500	3300	2200
25000	1200	4600	7500	1600	1500	3400	2300

Figure B-III-3. Example of preclusion-of-damage/-obstacles portions of the safety distance table.

(5) *Example of use of the safety distance table.*

(*a*) *Given:* Delivery system — freeflight rocket
Yield=10 KT
Range=23,400 meters
HOB—low air
Type of trees—coniferous
Type of fuel—dry.

(*b*) *Find:* The LSD for tree blowdown and the LSD for fire.

(*c*) *Solution:*

1. Step 1. Enter figure B-III-3 with the range of 23,000 meters. (Remember that LSD is not dependent on target category.) Moving to the right, under the column for tree blowdown coniferous, read the LSD as 1,500 meters. This is the least distance that must separate the DGZ and the area of interest to preclude tree blowdown.

2. Step 2. To find the LSD for fire, use the same procedure as that in

1, above, but move to the column for fires, dry fuel, and read the LSD as 3,300 meters.

B–III–5. Preclusion of Damage

a. Preclusion of damage to bridges or buildings is often dictated by the tactical or the political situation. Because of this, the least separation distances necessary to preclude damage are listed in the safety distance tables in FM 101–31–2 and FM 101–31–3 under the columns for preclusion of damage (fig. B–III–3). Also listed are the least separation distances for light aircraft in flight.

b. The procedure for extracting the least separation distances for damage is the same as that for obstacles (para B–III–4*d*(5)). The subheadings under the main heading *Preclude Damage* are discussed in (1) through (3) below.

(1) *Moderate damage to fixed bridges.* Moderate damage to a bridge is defined as damage that reduces the load-carrying capability of the bridge by 50 percent. If the desired ground zero and the bridge are separated by the least separation distance, there is a 90-percent probability that the bridge will not be moderately damaged.

(2) *Light damage to buildings (1 psi).* Light damage to buildings is defined as the blowing in of windows and doors and the cracking of interior partitions. Normally, light damage to frame buildings is associated with 1-psi overpressure. If the desired ground zero and the nearest building are separated by the least separation distance, there is a 90-percent probability that the building will not receive light damage.

(3) *Light aircraft in flight.* The least separation distances given for light aircraft in flight include the consideration that, if the desired ground zero and the aircraft are separated by the least separation distance, there is a 99-percent probability that the aircraft will be able to continue its mission.

c. It will be necessary for the analyst to determine the preclusion of damage to structures and materiel other than those listed in the safety distance tables. In these instances, the analyst will use the procedures listed in annex B–V to this appendix with data extracted from the effects tables found in FM 101–31–2 and FM 101–31–3.

GLOSSARY

This glossary is provided to enable the user to have readily available terms peculiar to nuclear weapon employment, as used in this manual. Terms that appear in JCS PUB 1 and AR 310-25 are not reproduced herein.

Across the board—Used in connection with weapon effects curves. It indicates that consideration is given to all the effects curves that describe radiation doses, blast effects on various drag-type targets, thermal effects and overpressures.

Alpha Particle—A particle ejected spontaneously from the nuclei of some radioactive elements. It is identified with the helium nucleus, which has an atomic weight of four and an electric charge of plus two.

Atmospheres—A measure of normal atmospheric pressure (e.g., 2 atmospheres indicate two times the normal atmospheric pressure).

Average coverage (*f*)—The coverage one could expect if a large number of weapons were fired under the same conditions.

Beta Particle—A small particle ejected spontaneously from a nucleus of either natural or artificially radioactive elements. It carries a negative charge of one electronic unit and has an atomic weight of 1/1840.

Circular distribution 90. (*CD90*)—The radius of a circle around the desired ground zero within which one weapon has a 90-percent probability of arriving.

Fractional coverage (*f*)—The coverage one could expect if a weapon was fired at a small area target.

Gamma Rays—Electromagnetic radiations, similar to X-rays, but of much higher energy, originating from the atomic nucleus.

Graphical portrayal—A two-dimensional representation (generally to scale) of the distance that the specified effects extend. It is also a visual representation of the results of an analysis.

Least separation distance (*LSD*)—A distance between Desired Ground Zero (DGZ) and a point of interest at or beyond which there exists at least a 90-percent assurance of preclusion of obstacles and/or damage. The LSD is the sum of the radius of effects and weapon delivery errors.

Militarily significant weapon effects—Those effects that will have a definite influence on the military capabilities or the degree of risk. See also *Tactically significant weapon effects.*

Minimum-dose exist route—The route of egress from a radioactive-contaminated area that presents the smallest amount of radiation to the existing party or parties.

Neutron—An atomic particle. Neutrons are produce in large numbers in the fission and fusion reactions. Neutrons and gamma radiation constitute the military significant nuclear radiation.

Nonsymptomatic dose—A dose of radiation that may not be detected because the recipient does not display the behavior or physical characteristics that would normally accompany such a dose.

Preinitiation—The premature commencement of fissioning in the active material of a nuclear weapon before the degree of design super-criticality is achieved, resulting in a reduced yield.

QSTAG—Effective 20 September 1967, ABCA Army materiel and non-materiel agreements have been designated Quadripartite Standardization Agreements (QSTAGs). The terms "SOLOG" and "ABCA Army Standard" apply only to agreements promulgated before that date.

Readiness status—Indicate the degree of preparation of both the weapon and the delivery unit for delivery of nuclear fires (to include air-delivered weapons).

Rem (*roentgen equivalent, mammal*)—Unit of absorbed dose used to express biological damage resulting from different types of radiation.

Rep (*roentgen equivalent, physical*)—Unit of absorbed dose from any type of radiation, with a magnitude of about 97 ergs per gram of soft tissue (muscle).

SOLOG—(Standardization of Operations and Logistics): A non-materiel agreement among the Armies of the United States, the United Kingdom, Canada and Australia, the "ABCA" nations.

Soft targets—Those targets that are easily damaged by low-magnitude nuclear weapon effects (e.g., exposed personnel, most buildings (particularly frame), forest, and crops).

Surveying (*Radiological*)—The directed effort to determine the extent and dose rates of radiation in an area.

Tactically significant weapon effects—Those effects that will have a definite influence on the military action currently underway. See also *Weapon system.*

Weapon—An assembled and ready-for-delivery nuclear device in the military configuration. For artillery, a weapon is a complete round; for a rocket, the motor plus the warhead; for a missile, the complete missile, to include the warhead; for an air-delivered weapon, the warhead in the bomb; and for an atomic demolition munition, the complete munition. See also *Weapon system.*

Weapon system—The complete weapon plus the associated delivery means. See also *Weapon.*

Worst-case burst—In analyzing targets, it indicates the location of the burst that occurs at the outer limits of the acceptable dispersion in both range and elevation. In considering the vulnerability of friendly forces, it indicates the point of maximum damage.

X-ray—Electromagnetic radiations of extremely short wave length.

U. S. GOVERNMENT PRINTING OFFICE : 1970 O - 373-351